The Meteorological Magazine

Air Ministry :: Meteorological Office

Vol. 57

Dec. 1922

No. 683

LONDON : PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.

To be purchased through any Bookseller or directly from
H.M. STATIONERY OFFICE at the following addresses:
IMPERIAL HOUSE, KINGSWAY, LONDON, W.C. 2, and 28, ABINGDON STREET, LONDON, S.W. 1; 37, PETER STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF; 23, FORTH STREET, EDINBURGH; or from THE METEOROLOGICAL OFFICE, SOUTH KENSINGTON, LONDON, S.W. 7.

The Evolution of Climate: A Review.

BY HUGH ROBERT MILL, D.SC.

GEOLOGISTS have earned the reputation of being a speculative and controversial folk, and in no department of their activity have speculation and controversy run riot so furiously as in the consideration of the climate of byegone times. Few investigators would dare to face the prodigious literature which has accumulated on the subject and one's first thought on opening this book is one of admiration of Mr. Brooks's courage in tackling his task. I doubt if there is such a quaking bog of contradictory and ill-arranged data slithering about under so dense a gloom of ignorance and prejudice as in the records of research into the Glacial Period which form the bulk of Mr. Brooks's study; but he seems to have found a way across it, and is able to shed most interesting light upon his subject.

No doubt Mr. Brooks adopted the best arrangement when he began his discussion of past climate with the oldest geological epoch, then went on to his main theme, the Glacial Period, and finally treated of pre-historic and historic times. Yet, in some ways, it might appear more logical to approach the past from the present, and so gradually acquire familiarity with the methods of inferring changes of climate from archæological and geological observations, before entering on the interpretation of the bewildering records of the oldest rocks.

Mr. Brooks is perhaps too modest in not accentuating the

The Evolution of Climate. By C. E. P. Brooks, M.Sc., F.R.A.I., F.R. Met. Soc. With a Preface by G. C. Simpson, D.Sc., F.R.S. $8\frac{1}{2} \times 5\frac{1}{2}$, pp. 174. London: Benn Brothers, Ltd, 1922. 8s. 6d. net.

z (64)19150 Wt 69—P 1 1000 12/22 E & S A 2

additions to the general sum of knowledge made by his own method of calculating climatic changes from changes in elevation and in the distribution of land and water. He gives so much credit to the work of others that every reader may not appreciate how much original work this little book contains. This defect is in large measure made good by Dr. Simpson's sympathetic preface, which deserves to be read with close attention. The student who wishes to go further is helped by a carefully selected bibliography to each chapter. This shows an admirable restraint, for the temptation must have been great to cite a much larger number of authorities. I should have liked to see a reference to the useful pioneer work of Mr. F. W. Harmer, whose method of preparing isobaric charts of Tertiary Climate, described at the Bradford meeting of the British Association in 1900, induced this magazine to refer to his discovery of "fossil cyclones." Mr. Brooks makes excellent use of a similar method, and carries it far, considering the very contracted space to which he confines himself.

The plan of the book is thus indicated in the Introduction.

"Chapter I. deals generally with the causes of climatic fluctuations and with the meteorology of an Ice Age. Chapter II. gives a brief account of the climatic record as a whole, and Chapter III. deals with the Tertiary Period considered as leading up to the Quaternary Ice Age. Chapter IV. discusses the subdivisions of the Glacial period, and the conflict between advocates of one and of repeated glaciations. Chapters V. to XII. give brief accounts *from the standpoint of a meteorologist* of the glacial history of Northern Europe, the Mediterranean Region, Asia, North and South America, Africa, Australia and the South Polar Regions. In Chapters XIII. to XV. post-Glacial climatology is considered. Chapters XVI. and XVII. deal with the major climatic fluctuations of the "historic" period and finally in Chapters XVIII. and XIX. is a short discussion of the influence of climate on the evolution and history of man."

It is impossible as yet to make much of the earlier ice-ages, beyond the fact that they occurred and passed away. The causes, whether astronomical or geographical, were probably the same as those which were at work in the Glacial Period of the Quaternary, a consideration of which fills a good half of the book. Mr. Brooks lays less stress on astronomical causes than on physical changes in the crust of the Earth as instrumental in starting an ice-age. He shows how the great mountain ranges which were formed at the close of the Tertiary Period, led to changes of climate through the lowering of air-temperature and the increased precipitation of snow on the mountain summits, the area of the snow-field tended to increase and to induce the formation of a glacial anticyclone and so drive the tracks of depressions into

new positions, thus completely altering the climate of large areas. On the other hand, the subsidence of an area of high land brings it below the snow-line, and ice-fields which had been formed would rapidly diminish, and with the dissipation of the glacial anticyclone the storm tracks would readjust themselves and change the climate of a very wide area.

Forty years ago geologists were fighting for the unity of the Great Ice Age, and resenting the revolutionary ideas of Prof. James Geikie and his school, who laid great stress on the thin peat-beds which were found buried in boulder clay as evidence of a genial period alternating with a glacial. Now the existence of several inter-glacial periods is recognised in most parts of the world and Mr. Brooks traces them out for each of the continents and, by his new method, even attempts to evaluate the changes of temperature they represent. It is impossible to make these chapters entertaining reading, for there is little to distinguish one glacial phase from another until in the later stages the migrations of animals and plants can be traced in relation to them. When the patient reader works through the chapters on the Ice Age he meets his reward in a fascinating presentation of the effects of climatic changes in the Human Period and here Mr. Brooks is at his best. Drawing his data from the work of anthropologists and archæologists on the one side and that of Mr. Ellsworth Huntington on tree-growth and of Prof. Otto Pettersson on marine temperatures and long lunar periods on the other, Mr. Brooks tells how the greatest climatic changes corresponded with, and were probably the cause of, the most important migrations of races. He shows how when the great civilisations of Egypt, Mesopotamia and Central Asia were at their height the climate of Europe was still dictated by the retreating polar and alpine ice-caps and unfit to support a highly civilised community; but that, as the climate of Europe improved, that of Asia began to suffer from chronic drought, the precursor of dessication and so the inhabitants were driven forth as hordes to people western Europe, now ready to receive them. This invasion took place in pulses when the drought was severe, separated by pauses when for a few generations its rigour relaxed, and thus our modern political geography and the unsolved Eastern and Near Eastern " Questions " are reducible to functions of climatic change.

Such an outlook on history gives a new depth and dignity to the study of meteorology, a new incentive to its students. A large part of what Mr. Brooks sets out will no doubt be controverted and some of it, perhaps, disproved; but he has blazed a trail into an almost unknown territory where much will yet be discovered to elucidate the past, and if we are sufficiently intelligent to profit by it, to help in the solution of practical problems of the present and future.

The Dynamics of the Circular Vortex.

Note on the Recent Work of Prof. V. Bjerknes.

By Sir NAPIER SHAW, F.R.S.

THIS paper* is the considered expression of Professor Bjerknes's mental picture of the dynamics of the earth's atmosphere which was sketched in lectures at the conference† between British and Norwegian meteorologists at Bergen in 1920.

We are invited to regard the general circulation of the atmosphere as a circumpolar vortex, and cyclonic depressions as examples of vortices, provisionally circular, developed out of wave motion in the polar front.

The general method of the paper is to study the dynamical conditions of a circular vortex, first in a homogeneous medium when the conditions are called barotropic; secondly, when there is a surface of discontinuity between two media each of which is homogeneous and therefore barotropic in itself but is baroclinic at or across the surface of discontinuity. For liquids, homogeneous means of equal density; for gases, of equal potential temperature.

In the analysis, *the properties* are expressed by pressure and density (or its reciprocal specific volume), and the *dynamics* by the relative positions of the surfaces of equal pressure, isobaric surfaces, and equal density, equi-substantial surfaces. If these are coincident the field is barotropic and if they cut one another it is baroclinic.

When the field is barotropic we have the conditions assumed in the classical hydrodynamics which prohibit the formation of vortices except at the boundaries. When the field is baroclinic the formation of a vortex is the natural expression of the distribution of forces.

Having made out, on these principles, the general distribution of temperature in the free atmosphere, in cyclones and anticyclones; and having connected vortices with initial wave motion in a surface of discontinuity, Professor Bjerknes points out the similarity between the results of these ideas and the results of well-known observations of the free air and the life cycle of cyclones as set out by J. Bjerknes.

We may summarize the results of the seven chapters of the paper as follows: (1) the examination of wave motion in relation to vortex motion gives a suggestion of the origin of vortices in

---

* *On the dynamics of the circular vortex with applications to the atmosphere and atmospheric vortex and wave motions.* By V. Bjerknes. *Geofysiske Publikationer*, Vol. II., No. 4. Kristiania, 1921. [Subject for discussion at the Meteorological Office, October 16th, 1922.]

† See *The Met. Mag.*, 1920, p. 166.

the atmosphere apart from the general circumpolar vortex. (2) The theory of the steady circular vortex with an assumed law of velocity in a medium separated into two parts by a discontinuity is developed so far as to determine the angles between the controlling force, the isobaric surfaces, the "equi-substantial" surfaces and the surface of discontinuity. (3) The application of the theory to the atmosphere with the discontinuity of the tropopause gives the relation of change of temperature to change of wind velocity at that discontinuity. These three propositions account for the general lines of distribution of temperature in the atmosphere regarded as a vortex about the polar axis, and the distribution of temperature in cyclones and anticyclones. (4) A cyclone is treated as a vortex with maximum spin in middle height and diminished spin at top and bottom, an anticyclone as a vortex with maximum spin at top and bottom and minimum spin in the middle; hence "pumping" in the middle of a cyclone and at top and bottom of an anticyclone. Whether the "pumping" has produced the velocity or velocity lost has expressed itself as "pumping" is not clearly stated.

The question of the rapid fall of temperature in the troposphere is not treated. Convection is excluded from consideration; motion is two-dimensional.

Attention is paid only to certain recognized discontinuities, viz., the tropopause, the polar front and, by way of suggestion, the trade wind lid. But in fact, with the definition of discontinuity that is adopted, there must be many others. Discontinuity as defined is not essentially different from a condition of stability; the atmosphere being stable may, therefore, be regarded as being generally separable into discontinuous layers according to its potential temperature and all physical action in the atmosphere of the nature of convection must have discontinuity associated with it. The atmosphere is therefore liable to the formation of vortices at all levels and in many circumstances and we ought not to be surprised at finding expressions of vortex motion of many kinds throughout the range of the atmosphere.

Official Publications.

British Rainfall, 1921. 9 × 6, pp. xxviii. + 324, 3 plates. Fully illustrated. Price 12s. 6d. net.

THIS volume is the sixty-first of the series issued by the British Rainfall Organization, the third published under the authority of the Meteorological Committee and the first since the removal of the headquarters from Camden Square to South Kensington.

The year under review was in some respects the most remark-

able yet discussed, being notable for the occurrence of the most widespread and severe drought since rainfall data for the British Isles first became available. Nearly the whole of the country south-east of a line drawn from Yarmouth to Plymouth, as well as part of the east of Scotland, in all about 18,000 square miles, experienced a total rainfall more than 40 per cent. below the average of 35 years; whilst more than 700 square miles, chiefly in Kent, had a deficiency of more than 50 per cent. Deficiencies of 40 per cent. in the rainfall of a calendar year are not unprecedented, but their occurrence has always been extremely local, and no previous instance has occurred since data became available of a deficiency approaching 50 per cent.

The conditions in the east of Kent were of a very remarkable nature. In parts of this district every month of the year had a rainfall below the average, and at one or two stations the total for the year fell short of 10 inches (250 mm.). Less than 12 inches (300 mm.) fell over a very large area in the lower Thames Valley and in the Fen District. In London, where fairly comparable statistics of rainfall go back to 1774, the year's fall was by far the smallest ever recorded.

Evidence of the remarkable nature of the year is shown in almost every section of the volume. The total duration of rainfall was at most stations far less than any previously recorded and the number of days with rain was probably also unprecedentedly small, less than 100 rain days occurring over a large area in the south-east of England. The number of days on which ·04 inch (1·0 mm.) of rain fell was in some places as low as 60. The infrequency of thunderstorms and of heavy cyclonic rains was a notable feature. In contrast with the conditions which prevailed in the south and east, the rainfall of the year in the west of Scotland was above the average. This is a phenomenon which has been common during previous droughts in England.

The volume contains an article comparing the rainfall data of the year with those of previous years in which prolonged dry periods occurred. These included the memorable droughts of 1868, 1879–80, and 1887; and the shorter, but in some respects more severe, drought during the spring of 1893. Other special articles deal with the correlation of rainfall statistics with those of epidemic scarlet fever and with the geographical aspects of annual rainfall fluctuation in the British Isles. The general tables of rainfall include records for 5,079 stations, an increase of 127 over those published in the volume for 1920, showing that the normal growth of the observing staff has been resumed after the depression caused by the War. There has been a distinct improvement in the distribution of the stations, especially in Scotland.

Professional Notes, No. 28. *A Comparison of the Anemometer Records for Shoeburyness and the Maplin Lighthouse.* By N. K. Johnson, B.Sc., and S. N. Sen, M.Sc. 1922. Price 6*d*. net.

THIS note gives details of an investigation of the anemometer records at Shoeburyness and at Maplin Lighthouse. Records for ten months of 1919 were utilized. The two stations are 12 miles apart, and the anemometers are almost identical in construction; that at Shoeburyness is, however, some 40 feet higher than that at Maplin. The high correlation coefficients show that there is a close relation between the wind speeds at the two places. The highest correlation coefficient obtained was ·93 for south, *i.e.* on-shore, winds, and the lowest ·72, for north, *i.e.* off-shore, winds.

Professional Notes, No. 30. *Diurnal Variation of Temperature as affected by Wind-velocity and Cloudiness: a Discussion of Observations on the Eiffel Tower.* By Captain J. Durward, M.A. 1922. Price 4*d*. net.

THE observations used in this investigation are those recorded at Parc St. Maur and at the top of the Eiffel Tower for the five months May to September during the years 1905–1909. Days and nights are considered separately, and these are again divided into "fair" and "cloudy." It is well known that cloudiness and turbulence are factors of temperature changes, but the numerical relation between the several factors is not readily obtainable. This gap in meteorological statistics is, in part, filled by Captain Durward's work.

Discussions at the Meteorological Office.

November 13th, 1922. *Het Klimaat van Nederlandsch-Indie.* By C. Braak. (Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verh. No. 8, Vol. I., part 2, 1921). *The Climate and Weather of the Philippines,* 1903–1918. By J. Coronas. (Manila: Philippine Weather Bureau, 1920.) Opener—Mr. C. E. P. Brooks.

The two papers under discussion are both valuable contributions to the climatology of the East Indies. The subject does not lend itself to a brief summary.

November 27th, 1922. *Die Zirkulation der Atmosphäre in den Gemässigten Breiten der Erde.* By A. Defant. (Stockholm: Geografiska Annaler, 1921, Vol. 3, pp. 209–266). Opener—Mr. R. G. K. Lempfert.

In this paper the author has applied the ideas underlying the theory of eddy motion to the general circulation of the

atmosphere and regarded the air flow in temperate latitudes as a case of steady motion on which is superposed eddy motion on a large scale, the cyclones, anticyclones and other disturbances being taken as the counterpart of the eddies experienced in the wind. He has endeavoured to work out the balance between the heat conveyed from the tropics towards the poles by this process, the heat received from the sun, and that lost by radiation. Some details in the analysis do not command full confidence, but the paper is suggestive and gave rise to an interesting discussion.

The subjects for discussion at 5 p.m. on Monday, January 22nd, 1923, will be :

Meteorological Conditions for the formation of rain. By J. Bjerknes and H. Solberg. (Geofysiske Publikationer, Vol. II., 1922, No. 3.)

Life Cycle of cylcones and the polar-front theory of atmospheric circulation. By J. Bjerknes and H. Solberg. (Geofysiske Publikationer, Vol. III., 1922, No. 1.)

The Royal Meteorological Society.

THE first meeting of the present session was held on November 22nd, Dr. Charles Chree, President, in the chair. Sir Napier Shaw gave an account of the proceedings* of the International Union for Geophysics and Geodesy which met at Rome in May 1922. A paper by Major Goldie followed.

A. H. R. Goldie, M.A.—Circumstances determining the distribution of temperature in the upper air under conditions of high and low barometric pressure. In this paper Major Goldie shows how the observations which are now being made day by day in aeroplanes can be utilized to throw light on the vexed question of the structure of the atmosphere in regions of high and low pressure. For this purpose he reviewed all the temperature observations made in the British Isles during the last three months of 1921. The maps of the *Daily Weather Report* were studied and showed whether the air in which the ascents took place was to be regarded as polar or equatorial. In the majority of cases the regular temperature lapse-rate showed that the currents extended to considerable heights, but there were a few instances of inversions where there was polar air near the

---

* See *The Meteorological Magazine*, June 1922, p. 120.

ground and equatorial air above. Major Goldie is led to adopt the view that the well-known association of low pressure with a cold troposphere, a low tropopause and a warm stratosphere is due to the fact that air in the polar regions has all these characteristics and that they are therefore to be expected in a polar current, *i.e.*, in air which has recently come from such regions. Similarly with equatorial air. The hypothesis explains the occasional combination of low temperature near the ground with high pressure as due to the presence of equatorial air over polar air.

It will be seen that the paper gives strong support to the theories of the Norwegian school, and is opposed to the idea that the contrast between the temperature distributions in cyclones and anticyclones is to be explained by the expansion and compression of the air as it rises and falls in the course of the adjustment between pressure and the centrifugal and "geostrophic" forces.

Certain difficulties were mentioned in the course of the discussion, emphasis being laid on the various reasons which make a sharp division between the categories, equatorial air and polar air, impracticable except in somewhat special circumstances.

Correspondence.

To the Editors, *The Meteorological Magazine.*

Cloud Transformations.

MR. G. A. CLARKE has asked for suggestions upon how the transformation from cirrus to cirro-cumulus can take place (see *The Meteorological Magazine*, 1922, pages 182–183). I have observed such changes occurring, apparently, in two ways. One is by the convectional breaking up of cirrus and cirro-stratus into cirro-cumulus. In this case the cirrus and cirro-stratus are formed by mixture, by general elevation, or possibly by radiation. Before their formation no thermal convection could take place locally in the air-sheet in question, unless the lapse-rate equalled or exceeded the adiabatic; after the formation of cloud, however, thermal convection may occur with any lapse-rates exceeding merely the retarded adiabatic. The process of the break-up of smooth sheets of lenticular alto-stratus into alto-cumulus by convection induced in this way is commonly to be observed, and gives us what I consider to be our most beautiful clouds. (*Cf.* Mr. Clarke's plates 14A, 14B, 18A, 20B, 21A, and 22B, in his recent book on clouds.)

A variant of this process is by evaporation of the cirrus and re-condensation of the vapour in the lower levels of the snow

trails. This re-condensation, which may occur first in the form of thin sheet clouds, may not be evident against the more brilliant background of the existing cirrus trails, until the thermal convection breaks the sheet into cirro-cumulus as described above. The levels of the movements of the cirrus and new cirro-cumulus may not be easily distinguishable.

A second process by which cirro-cumulus may "form from cirrus" is through thermal convection induced directly by the cold snow trails. The rise of the relatively moist air between dense cirrus trails, hanging perhaps more or less regularly from convectional columns above, may, on occasion, produce new cirro-cumulus, and in any event, produce disturbances in the cirrus trails. (Such as, perhaps, those in Mr. Clarke's plates 7B, 8B, and 12B, in his book on clouds.)

CHARLES F. BROOKS.

Clark University, Worcester, Mass., U.S.A., September 23, 1922.

Exceptional Visibility as a Sign of Coming Rain.

THE result of Mr. Pick's investigation, an account of which appeared in the October number of this magazine, as to whether a visibility of 21 miles or more can be regarded as a portent of rain, is of interest.

But may I point out that when Mr. Pick refers to "the widely-held belief that exceptional visibility is a sign of coming rain," exceptional visibility in this sense surely implies something more than a visibility of 21 miles or over. It implies a peculiar type of visibility which gives the impression of nearness. The air is remarkably transparent, and distant objects are unusually distinct. Meteorological observers in this country indicate this state of atmospheric transparency by the use of the Beaufort letter "v." It is this apparent "nearness" of distant objects which is widely believed to be a sign of coming rain. A visibility of 21 miles or more may often be observed, when an experienced observer would not log Beaufort "v." An idea of the frequency of occurrence of Beaufort "v" may be obtained from the fact that at Valencia Observatory, Cahirciveen, where visibility is, on the average, very good, Beaufort "v" has been observed during recent years on about 15 to 20 days per annum.

I think that one might reasonably maintain that Mr. Pick, in taking observations of visibility of 21 miles or more as expressing the same atmospheric conditions as implied by Beaufort "v", has not necessarily disproved the widely-held belief that exceptional visibility is a sign of coming rain.

The Valencia observations show, however, that for the Atlantic coast, at any rate, the belief is not justified.

P. I. MULHOLLAND.

5, Grenville Place, S.W.7, Oct. 22, 1922.

As to visibility, I hardly think the dry years of 1920 and 1921 can be quite sufficient evidence to disprove the popular theory.

As a rule when the hills this side of Sevenoaks, 22 miles off, are clear and dark, rain follows, and still more so when the flashes of the Gris Nez Lighthouse, 42 miles away, are distinct, or when the glare of London, 48 miles to the north-west, is plainly seen.

I particularly noticed this glare on the evening of September 18th this year after a very fine day with high barometer and no other sign of change. September 19th was wet and windy enough any way.

J. ELLIS MACE.

View Tower, Tenterden, October 19th, 1922.

A Huge Water Spout.

(From the *Daily Malta Chronicle*, October 26th, 1922.)

" During the night of Saturday, October 15th, while the Royal Fleet Auxiliary *Bacchus* was threading her way between the various islands of the Grecian Archipelago terrific thunder storms were encountered, accompanied by torrential rainfall, which lasted the whole night through and the great part of the following day. On the Sunday morning at 8.35 a.m., during a dazzling display of forked lightning and loud rumbling roars of thunder, the officer on watch was astonished to see, about 4 miles away from the ship, a long black looking streak of water, no thicker than a man's arm in appearance, shoot straight out of the sea to a height of 1,000 feet. Immediately this streak of water began to increase its dimensions until, in the space of two or three minutes, it had developed into a gigantic water-spout of 1,800 feet in height and 50 to 60 feet in diameter. Luckily it was travelling away from the vessel, but after eight minutes the most amazing spectacle was witnessed. From about half its height the water-spout bent to an angle of 45 degrees and then straightened out again. This feat was performed twice and the water dropping from this huge column created a base spray of 100 feet. After sixteen minutes existence, and as suddenly as it commenced, the water-spout collapsed amid a high commotion of sea. Everyone on board, and there are some [with] long service amongst them, agree that such wonderful specimens of a water-spout are seldom seen, and once seen never forgotten.

W. H. GIBSON."

[According to accepted ideas the shooting of the water-spout from the sea must be regarded as an optical illusion. The column is formed by the condensation of water in the centre of the whirlwind. There is usually much turbulence at the foot of the water-spout where water is being sucked up. The reference to water dropping from the column as the cause of base " spray " must be accepted with reserve.—Ed., *M.M.*]

A Persistent Rainbow: Porlock, September 16th, 1922.

THE persistent rainbow observed over the Porlock Valley from Dunkery Beacon is not an unusual occurrence in that district, as the clear patch of sky over the valley is nearly always, to a greater or less degree, present at certain times, when moist south-westerly winds blow. The general sequence of events is interesting. Before rain sets in or low cloud forms on the Exmoor heights, a band of cloud appears apparently over the middle of the valley, which is about 3 to 4 miles wide as measured from crest to crest of the hills bounding it. This band runs, roughly, north-west to south-east, and invariably has a smooth edge on its windward side. Its height is extremely difficult to judge, but must be 5,000 feet, or more, and it might be classed as lenticular strato-cumulus. The under-surface is dark and smooth. The position varies somewhat on different occasions, being sometimes nearer the Dunkery range than on others. This cloud-bank is a splendid guide to local weather likely to be experienced in the immediate future. So long as it is formed, no rain will fall in the adjacent valleys; but as soon as it begins to disperse rain may be expected. This part of Exmoor has a general slope upwards from south to north, culminating in the Dunkery range on its northern edge. From clouds observed, it seems that there must be a very considerable upward current from this edge, and it is this flow of air that forms the cloud-band. Small ragged fracto-stratus can frequently be seen rising, apparently from the valley, at a height of about 2,000 feet, evidently due to up-currents from the vale and in no way connected with the upper flow which forms the band. As the air becomes moister, cloud forms on the southern hills and drizzle sets in, while the high stationary band and the small fracto-stratus gradually disperse. Soon afterwards light drizzle commences, but rarely cloud forms on the North Hill on the northern side of the valley. The drizzle gradually spreads down the northern slopes of Exmoor to the valley; but often this is of short duration, and a clear patch of sky in much the same position as the cloud-band is formed, which gives rise to the rainbow effect in the drizzle over the North Hill. It thus appears that the flow of air at first has a considerable upward tendency, but later passes through horizontal to downward motion, after the local up-currents from the valley have ceased owing to the general equalising of temperature by the gradual spread of the drizzle into the valley area.

The time occupied by these changes, of course, varies considerably, and in the case of the latter stages may last for days.

Pilot-balloon ascents would doubtless clear up several points as to the air motion, which must necessarily remain obscure when eye observations alone are possible. T. F. TWIST.

Fawley, Hants, Nov. 22, 1922.

Turnip-like Clouds.

On Tuesday evening, October 10th, towards 17h, I observed a curious form of cloud. What struck me was the repetition of this form (like a turnip) in three separate clouds. The three clouds were fairly close to one another, about 10° or 15° above the horizon. The "outside left" specimen was almost due east-by-north and the "outside right," the largest of the three, practically due east, almost over the northern extremity of the low wooded hills situated east-south-east of the Observatory at a distance of 1½ miles. These hills are 400 feet high. The "turnip" clouds, which resembled cumulus in structure, being "puffy" like that type of cloud, but which had the pendants characteristic of tornado clouds, appeared to be stationary throughout the period in which I observed them until their disappearance, which was rather sudden. The phenomenon lasted about half-an-hour. The rest of the sky was covered with roll strato-cumulus (small rolls), amount 10, and wind was "calm."

I should be very glad to have your opinion on this curious phenomenon.

F. J. Parsons.

County Observatory, Ross-on-Wye, Oct. 13th, 1922.

Meteorology and Folklore.

The Wind.

The wind probably forced itself early upon the attention of man. He asked, naturally enough, "Was it divine?" "Could it be commanded?" This latter question is "answered" all over the world by magicians, who at all times and in every place have professed to control the wind.

This belief is mentioned in the Northern sagas. In Shakespeare, both the witches in *Macbeth* and Prospero in *The Tempest* command the elements. It was believed that witches raised a storm in order to wreck James VI. of Scotland and his bride. Nor is the belief quite extinct, since Sir J. G. Frazer tells us that the Esthonians attribute the bitter northerly winds of spring to the spells of Finnish wizards. They dread in particular three days called the Days of the Cross, one of which is Ascension Eve, and are afraid to go out on these days :—

"Wind of the Cross! rushing and mighty!
Heavy the blow of thy wings sweeping past!
Wild wailing wind of misfortune and sorrow,
Wizards of Finland ride by on the blast."

Any sudden wind may be supernatural—it is so inexplicable. So not only the formidable sand-storms of desert regions but the small dust whirls of our roads are almost universally ascribed

to spirits. To the Irish and Scots they are due to the fairies, to the Arabs they are the " Jan," while the Californian Indians say they are happy souls going to heaven. Some peoples make warlike demonstrations to drive away the demon, like the Esthonians, who run shrieking and shouting after a whirlwind, throwing sticks and stones at it. In some parts of Austria and Germany the peasants, during a wind, open a window and fling out a handful of meal, saying: " There, that's for you; stop!" In the south-east of France the Wandering Jew was said to be carried from place to place by the wind. This was probably a survival of the ancient Teutonic belief in the wind-god Odin or Wotan (derived from a Sanskrit root " to move "), who was said to ride through the air on his grey or white horse, or wander in disguise over the face of the earth, for the wind must wander.

The Hebrews thought of the winds as the messengers of Jehovah as in Psalm civ. In The Book of the Revelation the seer sees the four winds held by four angels at the four corners of the earth. Later Jewish legend tells of the " Angels of Wind and of Fire" who died as soon as born, as in Longfellow's beautiful lines :—

" The Angels of Wind and of Fire
Chant only one hymn, and expire
With the song's irresistible stress;
Expire in their rapture and wonder,
As harp-strings are broken asunder
By music they throb to express."

CICELY M. BOTLEY.

10 Wellington Road, Hastings, September 30th, 1922.

The Design of Rain-gauges.

WITH regard to gauges with high or low rims—I have had the two patterns for over 50 years and invariably find the Snowdon or Meteorological Office pattern gives the larger total for the year. The high rim catches more rain on showery days, but it protects the funnel in case of dew, the open gauge registering ·006 in. against ·004 in. or less in the standard shape and I often get 10 more " rain days " from this cause, chiefly in autumn or winter fogs and heavy dews. On the other hand, it is seldom that the fact that in high wind or hail the high rim catches more, makes the difference between a catch of less than ·005 in. into one reaching that limit and so as to add to the number of " rain days."

J. ELLIS MACE.

View Tower, Tenterden, October 19th, 1922.

NOTES AND QUERIES.

The Effect of introducing Ammonia into Pilot Balloons.

It having been suggested that the height reached by a pilot balloon might be increased by treating the rubber with ammonia gas before filling the balloon with hydrogen, Mr. L. H. G. Dines has been making some experiments at Benson, comparing the bursting size of balloons treated with ammonia and untreated.

The method of procedure was simply to put about ten drops of strong ammonia solution into a balloon and tie up the neck some two or three hours before filling it with air. The four balloons tested were slowly filled with air until they burst; the circumference at bursting could be measured by means of a piece of cotton to within a centimetre.

The circumference before filling was approximately 54 cm. in each case, but no attempt was made to determine it very closely.

The table below gives the particulars and results of the experiment. It will be noticed that the effect of the ammonia is not great, but that as far as it goes the experiment shows a slight advantage to be obtained by the treatment. The figures seem to be too consistent to be attributed entirely to chance, and it would be worth while making further trial of the process.

The balloons tested were all of good quality and none of them showed any signs of pin holes at any time before the final burst.

It is to be observed that if these particular balloons had been filled with hydrogen to give a velocity of 500 feet per minute their bursting size would have corresponded with a height of about $7\frac{3}{4}$ kilometres. Such a height would not often be attained in practice by balloons of this size inflated for a velocity of 500 feet per minute.

A possible explanation may be that the rubber is less durable at the low temperatures of the upper air than under the warmer conditions of the laboratory.

Colour of balloon and treatment.	Weight of balloon.	Circumference at time of burst.
	Grammes.	Cm.
White. No ammonia, but warmed a little - - - - - - -	19·6	196
White. Not warmed; treated with ammonia gas - - - - - -	19·7	204
Blue. No ammonia, but warmed a little	19·5	217
Blue. Not warmed; treated with ammonia gas - - - - - -	19·5	234

It is of interest to note that Mr. Dines's experience with registering balloons (made of much thicker rubber than pilots) is that when a balloon has been filled with ammonia gas for a day or two the smell comes through, but before that no smell can be detected outside. When rubber has been in contact with ammonia for some time the smell clings to it in a measure that suggests there has been more than superficial contact.

Evaporation from a Tank at Valencia Observatory.

A table in *British Rainfall, 1921*, gives the evaporation from a tank at Valencia Observatory, Cahirciveen, for the eleven months February to December, 1921. The following particulars of the tank and its exposure may be of interest.

The body of the tank is made of concrete, giving a water surface of 6 ft. square and a normal depth of 2 ft. All round the top of the concrete walls, which are 6 inches thick, a piece of $2\frac{1}{2}$ in. $\times$ $2\frac{1}{2}$ in. angle-iron is fixed, forming a definite edge flush with the inner face of the wall. A watertight joint is maintained between the iron and the concrete by means of pitch. The water level was normally maintained at about five inches below the top of the angle iron: the top of the wall is about one inch above the surrounding ground. The water level was thus not far from the ground level at any time.

The experience gained shewed that this form of tank in not very satisfactory, it is very difficult to make concrete walls watertight enough, even though every precaution may be taken in construction, and it was finally found necessary to coat the bottom with pitch. This had the desired effect, and whatever leakage still existed was entirely negligible.

The tank is built in a grass field not far from the estuary of the Valencia River, in an open exposure. In wet weather, when anything more than a light wind was blowing, a great deal of trouble was experienced owing to water splashing into the tank on the windward side from the top of the walls and the surrounding ground, making it impossible to determine the net evaporation by the usual method of deducting the rainfall from the depth of water in the tank.

It is evident in this connection that if water splashes in on the windward side it will at the same time splash out on the lee side, but there is reason to believe that the amount is much less. For one thing, direct observation during rainfall shewed this to be the case; it was also inferred by comparison with several rain-gauges, one of which was, owing to a bad exposure, suffering from excessive in-splashing. With none of the gauges was the

fall recorded always sufficient to account for the water found in the tank.

For this reason it was deemed undesirable to attempt to determine the mean monthly evaporation for all days indiscriminately, and only that on dry days has been published in *British Rainfall.*

It frequently happened that the maximum daily evaporation in a month occurred on a day of rain, and for the reason given above it is probable that the evaporation on such occasions was greater than the computed value which has been published. The principal factors in determining the amount of evaporation are a strong wind and dry air, conditions which are often associated with showers when a west-north-west or north-west wind is blowing at Cahirciveen.

It is a very difficult matter to determine the true evaporation from a tank on a rainy day and it is probably safe to say that it cannot be done directly at the present time. Not only is there the difficulty of water splashing into or out of the tank, but the rain-gauge itself is far from being a perfect instrument for determining the true depth of rainfall in windy weather.

It has been suggested that the tank records should be regularly compared with that of a Piche evaporimeter. If it be then assumed that there is a constant relationship between the true evaporation from the tank and that from the evaporimeter, irrespective of rain, then, from a comparison based on fine days only, the evaporation from the tank on all days may be computed. This method has much to recommend it and is being tried at Valencia Observatory at the present time.

The best kind of exposure for an evaporation tank is a matter of some dispute. If it be placed in a very sheltered position with a rain-gauge beside it, it is clear that the difficulty found at Valencia Observatory will be greatly minimised. Not only is the in and out splashing greatly reduced, but the rain-gauge itself will measure more accurately the true depth of rain falling into the tank under sheltered conditions, though in that case the primary factor connected with evaporation—a free play of air across the surface of the water—has been altered in a manner very difficult to standardize. If all tanks were exposed in open fields they would at least all be comparable in dry weather, but if they are in any way sheltered there is considerable risk that the mean evaporation is as much the result of a different exposure as of the climatic condition of the locality. It does not seem that this aspect of the case has been sufficiently emphasized.

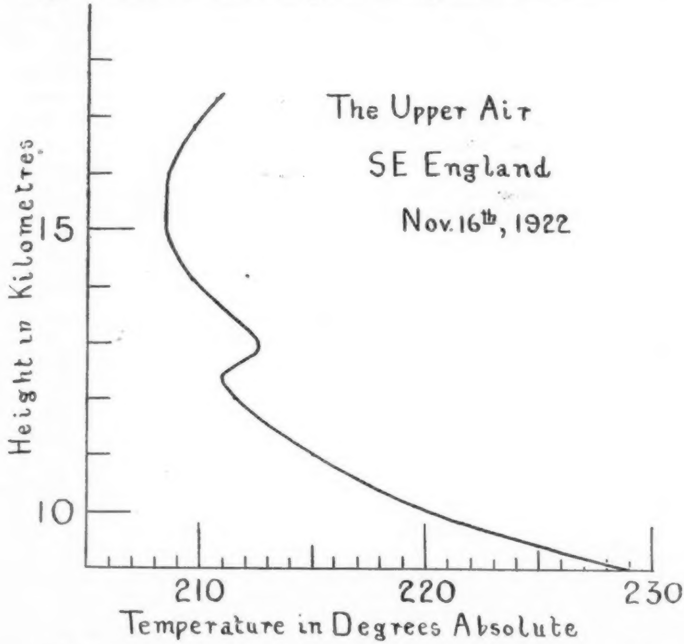
L. H. G. DINES.

Unusual Conditions at the Base of the Stratosphere.

A REGISTERING balloon was sent up from Benson on November 16th, 1922. Pressure was very high on the day of this ascent, and low clouds prevailed over England. Upper clouds were seen, however, in Scotland; the Aberdeen observations show that at the cirrus level the air movement was from the north.

The temperature conditions at the base of the stratosphere were very unusual. A lapse rate of 7a (12·6° F.) per kilometre was found between 11 km. and 12 km. and the stratosphere commenced with an inversion of 1·5a (2·7° F.) at 12·1 km. From 13 km. to 15 km. the lapse rate was again maintained at very nearly the same value as below the inversion. From 15 km. to 16 km. the temperature was uniform and above that it rose steadily at the rate of 3a (5·4° F.) or 4a (7·2° F.) per kilometre.

It would be of interest to learn whether a double inversion accompanied by such steep lapse rates has been recorded in the neighbourhood of the stratosphere on any other occasion.



The graph shows the temperatures found from 9 km. up to 17·2 km., the limit of the ascent.

"May Dust."

A NOTE on "May Dust" was published in *The Meteorological Magazine*, July 1922, p. 163. An explanation of this phenomenon is given in *The West India Committee Circular* of November 23rd, 1922.

"The phenomenon believed to be 'May Dust,' which was observed throughout the Windward and Leeward Islands, the Virgin Islands and Tobago, as well as in Jamaica and Porto Rico, in the middle of May this year, was mainly attributed to volcanic action by various correspondents in *The West India Committee Circular*,* who were struck by the resemblance which the haze bore to that noticed in Barbados in 1902 during the eruption of the St. Vincent Soufrière. Another explanation, however, is given by Mr. Oliver L. Fassig, the meteorologist in charge of Porto Rico Station, in his useful series† of 'Climatological Data.' Mr. Fassig says that a microscopical examination, while not revealing the source of the dust, makes it certain that it is not of volcanic origin. The most probable explanation, he thinks, for the wide extent of the haze is that great quantities of dust were carried aloft during one of the severe dust storms of the African deserts and then carried westward by the trade winds."

Leakage of Air into a Barometer Tube.

A MERCURY barometer with an unusual defect was recently brought to the Meteorological Office. The barometer, which was of considerable age, had been brought to London from the country, and on arrival mercury was up to the top of the tube. Inversion and judicious tapping apparently set matters right, but when the barometer was left to itself the mercury rose at a rate of about an inch an hour. When the tube, which was of uniform bore, was taken from its frame it was seen that bubbles formed at one particular spot on the glass about the middle of the tube. Each bubble grew to a certain size, then broke away and rose to join its predecessors in a larger bubble an inch or two up the tube.

No flaw could be seen in the tube at the spot where the bubbles were forming, but whilst it was under examination the tube snapped as if it had been in a state of strain. One of the fractures was at the place where the bubbles had formed. This fracture was clean with a radial crack from the bore half-way to the outer surface.

---

* No. 619, June 2, p. 294, and succeeding issues.

† *U.S. Department of Agriculture, Weather Bureau. Climatological Data. West Indies and Caribbean Service*, Vol. II., No. 5, May 1922.

Obituary.

Cargil Gilston Knott.—We regret to record the death, on October 26th, 1922, at the age of sixty-six, of Dr. Cargil Gilston Knott, F.R.S., Reader in Applied Mathematics in the University of Edinburgh. First a pupil, and then the assistant, of Professor P. G. Tait, Knott was from 1883 to 1891 Professor of Physics in the University of Tokyo, and whilst in Japan conducted a magnetic survey of that country and became absorbed in seismological problems. The last thirty years of his life were spent in the service of his own University, and for the last ten he was Secretary of the Royal Society of Edinburgh. He was President of the Scottish Meteorological Society at the time of its amalgamation with the Royal Meteorological Society two years ago, and the representative of the Royal Society of Edinburgh on the Advisory Committee for the Meteorological Office, Edinburgh.

Knott's devotion to a great master found expression in his admirable *Life of Tait* (Cambridge, 1911); he maintained in Edinburgh the traditions for which Tait had stood, and remained to the end a champion of quaternions. His published scientific papers are very numerous, and the most recent, in which he placed on record a new determination of the laws of propagation of seismic waves, perhaps the most valuable (*Proc. Roy. Soc. Edin.*, Vol. XXXIX., pp. 157-208). His book on *The Physics of Earthquake Phenomena* (Oxford, 1908) concerns itself chiefly with such phenomena as touch closely on physical theory.

Knott's generous mind endeared him to many friends, whom once made he never lost. It seems hardly possible that his place in the scientific life of the Scottish capital can be completely filled.

News in Brief.

We regret to announce the death of Mr. Clement Lindley Wragge who was for many years Government Meteorologist of Queensland and who founded many observatories both in England and Australia, that at Ben Nevis being perhaps the best known. An obituary will be published later.

The Prussian Aeronautical Observatory at Lindenberg has, since January, 1922, issued a monthly report of upper-air data. Wind, speed and direction, and temperature for each half kilometre from the ground up to 4 kilometres, are given, and a short account of the weather conditions prevailing during the month follows.

Corresponding data for August, 1920, to December, 1921, appeared in the *Zentralblatt für die gesamte Unterrichtsverwaltung in Preussen*, and an earlier series in *Das Wetter*.

It is announced that, through the Royal Aero Club, Messrs. Selfridge and Co. have offered a prize of 1,000 guineas for the first flight of 50 miles made by a British pilot with a British-built glider, the distance to be measured in a straight line from a given point of departure. The offer will remain open for one year, from January 1st, 1923. In the event of no award being made, 500 guineas will be given for the longest flight, greater than 25 miles, made during the year.

The *Enfield Gazette* of November 3rd, 1922, reports that Mr. J. McEwan who has for 30 years compiled the "Weather Notes" for that paper is obliged by ill-health to give up the work at the end of the year. It is hoped that a successor to Mr. McEwan will be found.

Erratum.

November 1922, page 284—for the entries in the column headed "Ratio of shocks recorded to shocks due" *read*:

—
10 : 49
10 : 80
10 : 58
10 : 62
—
—

The Weather of November, 1922.

November 1922 was, speaking generally, a quiet, cloudy, but mild and dry month over the British Isles. The mildness was particularly noticeable in Scotland and the north of England. Before considering the sequence of events in detail, it is of interest to examine the general flow of air during the month in relation to the normal.

Taking the rough parallelogram defined by Iceland, the Azores, Munich and the north of the Baltic, during November, there is on the average an inflow over the western boundary and an outflow towards east and north, with little or no transfer of air across the southern boundary. During the past month the flow from the west was less than normal and the outflow towards east much increased, while the normal outflow towards north was reversed.

Reports from many parts of the country indicate that our smaller bird immigrants, such as various finches as well as larger but feeble flyers like the woodcock, have arrived on our shores in unusual numbers—perhaps a direct consequence of the generally quiet conditions.

On the morning of the 1st, a large depression centred off the north of Scotland was associated with a warm south-west wind current, and heavy rain and gales were general over the British Isles. By evening the depression had moved eastwards to southern Norway, and cold " polar " air was flowing over our area, causing sleet and hail showers and night frost, followed next day by brighter weather. On the morning of the 3rd a secondary was situated over south-west England, giving rain in southern England and northern France. This disturbance moved up the Channel over the Netherlands and finally left our area east of Petrograd on Sunday the 5th. Heavy rains associated with this depression caused a rapid rise in the levels of the Marne and Rhone. At Chalons the Marne was nearly five feet above its normal level and the lower parts of Lyons were flooded, while heavy snow, interrupting communications between Savoy and Italy, was reported on the Col du Lantanet and the Petit Saint Bernard.

Behind this distubance a wedge of high pressure moved eastwards across the British Isles to Russia, giving a short period of fairer weather. By the 5th, however, a new depression was approaching the Hebrides and rain was falling in the western districts. The new depression was centred over Scotland on the 6th and moved northwards on the 7th. Secondaries, however, caused rain on the 8th over the English Channel and southern Scandinavia.

A wedge of high pressure following this complex system continued to grow in intensity, except for a lapse on Friday the 10th, when a secondary of a deep depression over Iceland crossed the British Isles, and by the morning of the 11th a ridge of high pressure was established from the Azores to northern Russia. This anticyclone was the dominating feature of the weather charts for the rest of the month, though there were considerable local variations of weather as a result of its movements and the passage of depressions along its northern margin.

From the 12th to the 16th, depressions moved in a north-easterly direction with their centres north of Iceland and strong south-west winds caused relatively high temperatures in Iceland and northern Scandinavia. Low temperatures and much fog occurred over England, the Netherlands and Germany as a result of the clear skies and absence of definite wind currents.

A movement of the anticyclone to the west and an extension northward beginning on the 16th brought about a strong north-westerly wind current over Scandinavia with lower temperatures. Though coming to us from the north, the air over the British Isles was warm during this period and of equatorial origin, sweeping up the westward side of the anticyclone, far out over the Atlantic, to Iceland and then moving south to the British Isles. On the 20th, the anticyclone began moving eastward again and

was centred over London on the 21st. The central parts of London experienced remarkable gloom on that day as the result of the formation of a pall of smoke at a height comparable with that of the roofs of buildings. Neither horizontal nor vertical air currents capable of dispersing the pollution existed and darkness as intense as that of night persisted almost throughout the day.

From the 21st, complex changes of pressure occurred and by the morning of the 24th, a crescent-shaped area of high pressure extended from Iceland over France to the Black Sea. Finally, the main anticyclone took up a position off south-west Ireland and the general conditions until the end of the month were similar to those prevailing between the 16th and 20th. A north-westerly current of "polar" air resulted in cold weather over Scandinavia and Central Europe, the highest temperature reported in this region on the 27th being 36° F. at Frankfurt. Over the British Isles the weather was much milder, though the surface wind direction was also north-westerly.

HEAVY floods occurred at Naples on the 4th, causing landslides and the collapse of several buildings, with some casualties. On the 28th it was reported that heavy snowstorms in Silesia had seriously impeded the frontier traffic with Poland.

Severe weather prevailed in mid-Atlantic from the 12th to the 14th. The Italian steamship *Monte Grappa* foundered on the 14th as a result of the shifting of her cargo. The crew were rescued by the White Star liner *Pittsburgh*. The ensuing week was, however, remarkably fine, an officer of the *Aquitania* stating that he could not recall a November voyage with so much sunshine and such smooth seas within the last 10 years.

From the 21st to the 23rd a violent gale was experienced at Sydney, Nova Scotia (Cape Breton Island) and over the island generally. Telegraph, telephone and power wires were blown down and the city was without light or power for tramway communication for over 24 hours. The gale is stated to be the worst that has occurred in the history of the island.

A Paris telegram, dated November 25th, gave details of torrential rains which had fallen in Algerian Sahara. The Biskra–Tuggourt railway was inundated at five points, and one train was surrounded by a flooded area extending for nearly 40 square miles. Tuggourt station was abandoned, and a large number of houses collapsed in places where there had been no rain since 1917.

Early in the month storms accompanied by floods were experienced over wide areas of the Cape and Transvaal. Shipping at Port Elizabeth was obliged to leave the roadstead. In many parts the rains were needed and proved very beneficial.

The special message from Brazil states that the rainfall was

(*Continued on p.* 322.)

Rainfall Table for November 1922.

STATION.	COUNTY.	Aver. 1881—1915. in.	1922. in.	1922. mm.	Per cent. of Av.	Max. in 24 hrs. in.	Max. in 24 hrs. Date.	No. of Rain Days.
Camden Square	*London*	2·36	1·43	36	61	·46	5	9
Tenterden (View Tower)	*Kent*	3·02	1·51	38	50	·55	1	11
Arundel (Patching Farm)	*Sussex*	3·56	1·94	49	54	·62	5	10
Fordingbridge (Oaklands)	*Hampshire*	3·42	2·39	61	70	·86	5	19
Oxford (Magdalen College)	*Oxfordshire*	2·21	1·10	28	50	·42	5	11
Wellingborough (Swanspool)	*Northampton*	2·15	1·03	26	48	·25	1, 5	10
Hawkedon Rectory	*Suffolk*	2·27	1·47	37	65	·37	5	12
Norwich (Eaton)	*Norfolk*	2·57	2·01	51	78	·44	1	15
Launceston (Polapit Tamar)	*Devon*	4·24	2·74	70	65	·79	6	12
Sidmouth (Sidmount)	„	3·12	1·70	43	55	·40	5	12
Ross (County Observatory)	*Herefordshire*	2·53	1·39	35	55	·46	5	13
Church Stretton (Wolstaston)	*Shropshire*	2·94	1·80	46	61	·63	6	11
Boston (Black Sluice)	*Lincoln*	2·00	1·11	28	55	·38	6	9
Worksop (Hodsock Priory)	*Nottingham*	1·96	·91	23	46	·37	6	10
Mickleover (Clyde House)	*Derbyshire*	2·23	·90	23	40	·20	6	9
Southport (Hesketh Park)	*Lancashire*	3·14	2·53	64	81	1·19	6	17
Wetherby (Ribston Hall)	*York, W. R.*	2·34	1·25	32	53	·48	6	5
Hull (Pearson Park)	„ *E. R.*	2·19	1·61	41	74	·70	6	14
Newcastle (Town Moor)	*North'land*	2·42	·83	21	34	·20	3	11
Borrowdale (Seathwaite)	*Cumberland*	13·58	5·40	137	40	..	..	..
Cardiff (Ely Pumping Stn.)	*Glamorgan*	4·17	2·35	60	56	·84	5	22
Haverfordwest (Gram. Sch.)	*Pembroke*	5·02	2·24	57	45	·72	5	16
Aberystwyth (Gogerddan)	*Cardigan*	4·72	1·88	48	40	·51	6	6
Llandudno	*Carnarvon*	3·09	1·19	30	39	·34	3	15
Dumfries (Cargen)	*Kirkcudbrt.*	4·52	1·70	43	38	·72	5	10
Marchmont House	*Berwick*	3·00	·92	23	31	·21	10	14
Girvan (Pinmore)	*Ayr*	5·32	4·42	112	83	·99	10	24
Glasgow (Queen's Park)	*Renfrew*	3·73	2·15	55	58	·48	10	14
Islay (Eallabus)	*Argyll*	5·38	4·19	106	78	1·14	9	27
Mull (Quinish)	„	6·17	5·48	139	89	1·05	9	23
Loch Dhu	*Perth*	8·69	6·20	157	71	1·80	5	16
Dundee (Eastern Necropolis)	*Forfar*	2·44	1·37	35	56	·52	10	10
Braemar (Bank)	*Aberdeen*	3·84	1·62	41	42	·35	27	12
Aberdeen (Cranford)	„	3·22	2·20	56	68	·74	10	22
Gordon Castle	*Moray*	2·88	2·48	63	86	·60	25	19
Fort William (Atholl Bank)	*Inverness*	8·16	6·27	159	77	1·13	9	26
Alness (Ardross Castle)	*Ross*	4·02	2·38	61	59	·62	1	24
Loch Torridon (Bendamph)	„	9·27	7·51	191	81	1·02	30	28
Stornoway	„	5·83	3·74	95	64	·46	30	24
Loch More (Achfary)	*Sutherland*	8·55	9·93	252	116	1·04	25	29
Wick	*Caithness*	3·14	2·67	68	85	·67	25	26
Glanmire (Lota Lodge)	*Cork*	4·30	2·10	53	49	·57	5	15
Killarney (District Asylum)	*Kerry*	5·61	2·49	63	44	·47	5	20
Waterford (Brook Lodge)	*Waterford*	3·78	1·47	37	39	·76	5	11
Nenagh (Castle Lough)	*Tipperary*	4·02	1·27	32	32	·34	5	15
Foynes	*Limerick*	3·99	1·72	44	43	·53	5	15
Gorey (Courtown House)	*Wexford*	3·49	1·23	31	35	·60	5	12
Abbey Leix (Blandsfort)	*Queen's Co.*	3·34	·78	20	23	·20	5, 6	11
Dublin (FitzWilliam Square)	*Dublin*	2·67	·31	8	12	·10	6	9
Mullingar (Belvedere)	*Westmeath*	3·41	·78	20	23	·23	4	11
Crossmolina (Enniscoe)	*Mayo*	5·86	..	..	..	..	..	..
Collooney (Markree Obsy.)	*Sligo*	4·16	2·79	71	67	1·00	9	20
Seaforde	*Down*	3·79	1·54	39	41	·53	9	11
Ballymena (Harryville)	*Antrim*	4·05	2·33	59	58	·68	9	23
Omagh (Edenfel)	*Tyrone*	3·80	2·61	66	69	·75	9	24
Letterkenny Asylum	*Donegal*	4·85	2·82	72	58	·72	9	22

Correction—Stornoway, October, *for* "3·30 \| 84 \| 64," *read* "3·07 \| 78 \| 59."

Supplementary Rainfall, November 1922.

Div.	STATION.	RAIN. in.	RAIN. mm.
II.	Ramsgate	1·03	26
„	Sevenoaks, Speldhurst	1·95	49
„	Hailsham Vicarage	2·14	54
„	Totland Bay, Aston Ho.	2·00	51
„	Ashley, Old Manor Ho.	1·95	49
„	Grayshott	2·17	55
„	Ufton Nervet	2·05	52
III.	Harrow Weald, Hill Ho.	1·71	43
„	Pitsford, Sedgebrook	1·38	35
„	Chatteris, The Priory	·80	20
IV.	Elsenham, Gaunts End	1·28	33
„	Lexden, Hill House	1·36	35
„	Aylsham, Rippon Hall	2·30	58
„	Swaffham	1·44	37
V.	Devizes, Highclere	1·51	38
„	Weymouth	2·22	56
„	Ashburton, Druid Ho.	4·61	117
„	Cullompton	2·13	54
„	Hartland Abbey	1·88	48
„	Penzance, Morrab Gdn.	2·01	51
„	St. Austell, Trevarna	2·97	75
„	Crewkerne Merefield Ho	2·62	67
VI.	Clifton College	..	..
„	Ledbury, Underdown	1·12	28
„	Shifnal, Hatton Grange	1·31	33
„	Ashbourne, Mayfield	1·68	43
„	Barnt Green, Upwood	1·27	32
„	Blockley, Upton Wold	1·79	45
VII.	Leicester, Town Hall Sq.	·93	24
„	Grantham, Saltersford	1·20	31
„	Louth, Westgate	1·58	40
„	Mansfield, West Bank	1·28	33
VIII.	Nantwich, Dorfold Hall	1·22	31
„	Bolton, Queen's Park	4·16	105
„	Lancaster, Strathspey	2·54	65
IX.	Wath-upon-Dearne	·78	20
„	Bradford, Lister Park	·90	23
„	West Witton	1·03	26
„	Scarborough, Scalby	1·86	47
„	Middlesbro', Albert Pk.	·72	18
„	Mickleton	..	..
X.	Bellingham	·78	20
„	Ilderton, Lilburn	1·57	40
„	Orton	3·05	77
XI.	Llanfrechfa Grange	2·35	60
„	Treherbert, Tyn-y-waun	5·28	134
„	Carmarthen Friary	2·18	55
„	Lampeter, Falcondale	2·18	55
„	Cray Station	3·00	76
„	B'ham W.W., Tyrmynydd	3·03	77
„	Lake Vyrnwy	3·07	78
„	Llangynhafal, P. Drâw	2·17	55
„	Oakley Quarries	5·65	143
„	Dolgelly, Bryntirion	4·12	105
„	Snowdon L., Llydaw 9	..	..
„	Lligwy	1·83	47
XII.	Stoneykirk, Ardwell Ho	2·21	56
„	Carsphairn, Shiel	6·15	156
XII.	Langholm, Drove Rd.	2·10	53
XIII.	Ettrick Manse	2·71	69
„	North Berwick Res.	1·06	27
„	Edinburgh, Royal Ob.	1·20	31
XIV.	Biggar	1·72	44
„	Leadhills	5·63	143
„	Kilmarnock, Agric. Coll.	3·08	78
XV.	Dougarie Lodge	4·65	118
„	Oban	4·99	127
„	Holy Loch, Ardnadam	..	..
„	Tiree, Cornaigmore	..	..
XVI.	Loch Venachar	5·80	147
„	Glenquey Reservoir	4·10	104
„	Loch Rannoch, Dall	2·48	63
„	Blair Castle Gardens	1·59	40
„	Coupar Angus	1·58	40
„	Montrose Asylum	1·51	38
XVII.	Logie Coldstone, School	1·61	41
„	Fyvie Castle	2·85	72
„	Grantown-on-Spey	2·13	54
XVIII.	Kingussie, Fasnakyle	1·78	45
„	Fort Augustus	3·09	79
„	Loch Quoich, Loan	9·10	231
„	Fortrose	1·19	30
„	Faire-na-Squir	4·15	105
„	Skye, Dunvegan	5·08	129
XIX.	Loch Carron, Plockton	7·45	189
„	Dornoch, St. Gilbert's	1·36	35
„	Tongue Manse	3·03	77
„	Melvich Schoolhouse	3·14	80
XX.	Dunmanway Rectory	3·42	87
„	Mitchelstown Castle	..	..
„	Gearahameen	..	..
„	Darrynane Abbey	3·50	39
„	Cashel, Ballinamona	1·42	36
„	Roscrea, Timoney Park	·87	22
„	Broadford, Hurdlestown	2·09	53
XXI.	Kilkenny Castle	1·26	32
„	Rathnew, Clonmannon	·91	23
„	Hacketstown Rectory	1·19	30
„	Balbriggan, Ardgillan	·50	13
„	Drogheda	·33	8
„	Athlone, Twyford	..	..
XXII.	Castle Forbes Gdns.	1·63	42
„	Ballynahinch Castle	..	..
„	Galway, Grammar Sch.	2·40	61
XXIII.	Westport House	4·13	105
„	Enniskillen, Portora	2·08	53
„	Crossdoney, Kevit Cas.	1·10	28
„	Armagh Observatory	1·20	31
„	Warrenpoint	1·11	28
„	Belfast, Cave Hill Rd.	1·77	45
„	Glenarm Castle	2·43	62
„	Londonderry, Creggan	2·97	75
„	Sion Mills	2·73	69
„	Milford, The Manse	3·28	83
„	Narin, Kiltoorish	2·96	75
„	Killybegs, Rockmount	4·12	105

Climatological Table for the

STATIONS	PRESSURE		TEMPERATURE							
			Absolute				Mean Values			
	Mean M.S.L. mb.	Diff. from Normal mb.	Max. °F.	Date	Min. °F.	Date	Max. °F.	Min. °F.	½ max. and min. °F.	Diff. from Normal °F.
London, Kew Observatory	1016·0	−0·2	84	1	45	16	68·4	51·1	59·7	+0·5
Gibraltar	1014·7	−1·1	89	26	57	6	77·2	62·5	69·9	−0·6
Malta	1015·2	+0·6	87	25	63	24	79·6	68·6	74·1	+2·1
Sierra Leone	1013·3	+0·6	91	3, 4, 5	69	20	86·1	73·6	79·9	−0·6
Lagos, Nigeria	1011·6	−1·3	88	2, 4	71	9, 25	85·1	74·7	79·9	+1·3
Kaduna, Nigeria	1012·2	−1·6	90	3	60	11	84·5	66·5	75·5	−0·5
Zomba, Nyasaland	1017·1	−0·3	85	18	50	22, 24, 25	75·0	54·4	64·7	+2·2
Salisbury, Rhodesia	1017·2	−3·0	80	6	32	22, 23	73·8	43·0	58·4	+2·0
Cape Town	1019·3	−1·0	81	8	34	26, 27	62·5	46·4	54·5	−1·3
Johannesburg	1022·2	−1·0	71	23	23	27	60·8	42·0	51·4	+0·7
Mauritius	..	..	..	..	..	..	..	..	..	..
Bloemfontein	..	..	68	23	25	27	59·2	34·1	46·7	−0·9
Calcutta, Alipore Obsy.	998·1	−0·9	95	11	75	7	88·7	78·3	83·5	−1·6
Bombay	1003·3	−0·9	92	1	76	21	87·8	80·0	83·9	0·0
Madras	1005·5	+1·6	107	14	75	1	100·9	80·9	90·9	+1·0
Colombo, Ceylon	1008·8	+0·5	88	4	73	2	86·5	77·4	81·9	0·0
Hong Kong	1005·1	−1·0	90	30	72	1	86·5	78·8	82·7	+1·2
Sandakan	..	..	91	14, 21	72	26	87·8	75·0	81·4	−0·3
Sydney	1018·8	+0·9	72	11	43	30	63·8	47·9	55·9	+1·5
Melbourne	1018·7	+0·2	67	17	32	24	57·2	41·4	49·3	−1·1
Adelaide	1019·5	+0·4	69	18	39	30	60·7	45·9	53·3	−0·1
Perth, Western Australia	1021·1	+3·1	72	4	39	25	63·6	48·4	56·0	−0·6
Coolgardie	1020·8	+1·7	74	5	32	26	63·1	43·4	53·3	+0·6
Brisbane	1018·2	+0·2	79	27	43	9	69·9	52·6	61·3	+1·2
Hobart, Tasmania	1018·0	+3·7	63	21	31	25	53·2	40·8	47·0	+0·2
Wellington, N.Z.	1023·2	+8·9	59	26	31	22	53·9	41·7	47·8	−1·9
Suva, Fiji	1013·2	−0·4	86	1	60	14	84·3	65·4	74·9	0·0
Kingston, Jamaica	1014·0	0·0	92	10	70	4	88·9	72·5	80·7	−0·6
Grenada, W.I.	1014·7	+1·4	87	3	72	4, 27	83·7	74·3	79·0	+0·2
Toronto	1014·3	0·0	91	7	45	13	77·1	56·3	66·7	+4·1
Winnipeg	1012·3	−0·2	96	5	37	9	77·8	51·5	64·7	+2·5
St. John, N.B.	1015·0	+1·0	77	5, 9	44	13	65·3	49·4	57·3	+0·8
Victoria, B.C.	1017·1	+0·2	78	19	45	17	64·8	49·7	57·3	+0·3

London, Kew Observatory.—Prevailing wind direction W., mean speed 8·0 mi/hr. 1 day with hail, 1 day with thunder heard.

Gibraltar.—Prevailing wind direction E.

Malta.—Prevailing wind direction NW. 3 days with hail.

Sierra Leone.—Calms predominate. 2 days with tornado, 11 days with thunder heard.

Lagos, Nigeria.—Prevailing wind direction SW.

Salisbury, Rhodesia.—Prevailing wind direction easterly.

Colombo, Ceylon.—Prevailing wind direction WSW, mean speed 6·7 mi/hr. 1 day with thunder heard.

British Empire, June 1922.

Temperature: Mean Wet Bulb °F.	Temperature: Absolute Min. on Grass °F.	Relative Humidity %	Mean Cloud Am'nt 0–10	Precipitation: Amount in.	Precipitation: Amount mm.	Precipitation: Diff. from Normal mm.	Precipitation: Days	Bright Sunshine: Hours per day	Bright Sunshine: Percentage of possible	STATIONS
54·4	33	62	6·3	0·98	25	− 30	10	7·5	46	London, Kew Observatory
63·0	54	71	3·2	0·61	16	+ 4	4	..	..	Gibraltar.
66·6	62	66	3·3	0·02	1	− 1	1	9·0	62	Malta.
75·5	..	77	7·4	15·86	403	− 87	25	..	..	Sierra Leone.
76·7	69	79	8·3	26·36	670	+187	21	..	..	Lagos, Nigeria.
69·8	..	75	1·0	6·76	172	− 53	12	..	..	Kaduna, Nigeria.
..	..	82	3·7	0·38	10	− 5	5	..	..	Zomba, Nyasaland.
51·0	..	51	1·5	0·01	Trace	− 1	1	..	..	Salisbury, Rhodesia.
50·6	..	76	5·9	4·18	106	− 7	15	..	..	Cape Town.
40·5	22	54	1·8	0·37	9	+ 6	3	8·8	84	Johannesburg.
..	..	..	..	..	..	..	..	..	..	Mauritius.
36·8	..	74	3·2	2·05	52	+ 40	3	..	..	Bloemfontein.
80·1	69	79	9·3	22·89	581	+291	20*	..	..	Calcutta, Alipore Obsy.
78·7	69	77	6·8	26·63	676	+207	24*	..	..	Bombay.
77·3	72	57	5·8	1·30	33	− 15	12*	..	..	Madras.
78·5	72	75	9·0	9·86	250	+ 58	25	..	..	Colombo, Ceylon.
77·5	..	81	7·9	6·53	166	−232	16	6·1	45	Hong Kong.
76·5	..	82	..	8·69	221	+ 36	12	..	..	Sandakan.
51·6	36	70	4·1	1·26	32	− 95	12	5·3	54	Sydney.
47·2	29	80	5·8	1·80	46	− 7	15	..	..	Melbourne.
49·1	29	74	6·1	2·80	71	− 7	14	4·4	45	Adelaide.
52·9	29	75	5·0	4·09	104	− 68	18	5·7	57	Perth, Western Australia
49·8	28	62	4·4	0·67	17	− 14	5	..	..	Coolgardie.
57·6	37	70	4·6	1·83	46	− 19	8	..	..	Brisbane.
44·0	25	80	5·7	1·85	47	− 9	12	4·8	53	Hobart, Tasmania.
44·4	19	77	7·0	3·32	84	− 37	18	3·6	39	Wellington, N.Z.
71·6	..	83	5·9	1·82	46	−110	10	..	..	Suva, Fiji.
..	..	71	5·3	0·94	24	− 81	4	..	..	Kingston, Jamaica.
74·5	..	77	5·9	6·30	160	− 59	22	..	..	Grenada, W.I.
59·5	40	73	5·3	4·89	124	+ 54	11	..	..	Toronto.
58·7	..	67	4·0	2·28	58	− 25	10	..	..	Winnipeg.
53·7	41	87	7·0	3·07	78	− 5	16	..	..	St. John, N.B.
51·8	38	77	3·3	0·03	1	− 23	1	..	..	Victoria, B.C.

* For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen.

HONG KONG.—Prevailing wind direction S, mean speed 10·4 mi/hr. 4 days with thunder heard.

SANDAKAN.—Prevailing wind direction NE.

MELBOURNE.—11 days with fog. Night temperatures very low, 5 frosts.

PERTH, W.A.—Mean speed of wind 8·8 mi/hr.

WELLINGTON, N.Z.—Prevailing wind direction S. 1 day with hail.

SUVA, FIJI.—Wind direction variable.

GRENADA, W.I.—Prevailing wind direction E., 2 days with thunder heard.

(*Continued from p. 317.*)

slightly above normal in the centre and north of the country and irregular in the south. The atmospheric circulation was less active than in October, but several high pressure areas passed across southern Brazil and there were severe local storms with hail at various points in the centre and south, where some of the coffee plantations suffered damage. At Rio de Janeiro pressure during November was 4mb. above normal and temperature was slightly below normal.

A Correction.

With reference to the Barbuda hurricane mentioned on p. 288 of the November number of this magazine it is regretted that an error was made in the date. The hurricane occurred on the night of September 15th, and the centre of the storm is said to have passed directly over the island. Great damage was done to property, churches, houses and trees being blown down, but there was no loss of life. All shipping was driven ashore. The storm was experienced at Anguilla a few hours later, but the wind was less intense than at Barbuda. St. Christopher and Nevis Islands suffered practically no damage.

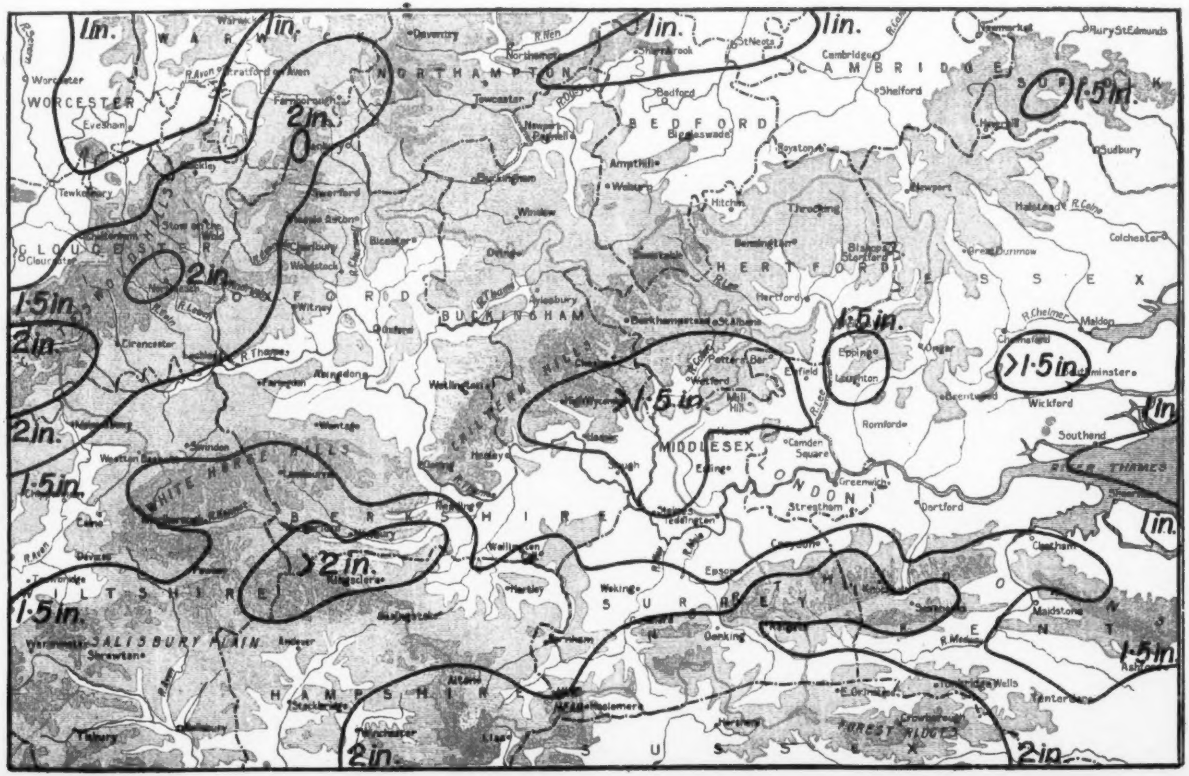
Rainfall in the British Isles.

THE deficiency of rainfall which occurred generally over the British Isles in October, continued in November, giving two consecutive months of abnormally low rainfall. The general rainfall in November was the smallest recorded since 1909, and for the two months together for a considerably longer period. The distribution of the rainfall in November 1922, differed from that of the preceding month in showing a greatly reduced tendency for excess along the east coast. The rainfall approximated most closely to the normal in the north-west where a considerable area had a deficiency of less than 25 per cent. The largest deficiency occurred in a broad band extending from the south-west of Ireland to the north-east of England, culminating at Dublin in a deficiency of 88 per cent. Over the greater part of the south of England the rainfall was between 50 and 70 per cent. of the average. The most unusual feature was a small area on the coast of Ireland, from Drogheda to Dublin, where the rainfall of the month was about 8mm. (0·3 inch). A considerable area in the eastern centre of Ireland and of England, as well as the north-east coast of England, had a rainfall of less than 25mm. (1 inch) for the month.

The general rainfall, expressed as a percentage of the average, was: England and Wales, 55; Scotland, 70; Ireland, 42; British Isles, 56.

In London, Camden Square, the mean temperature for November was 43·1° F., or 0·3° F. below the average. Duration of rainfall 28·2 hours. Evaporation, 0·27 inch.

THAMES VALLEY RAINFALL —— NOVEMBER, 1922.



Watershed of River Thames above Teddington and River Lee above Feilde Weir. —— Isohyetals

ALTITUDE SCALE: Below 250 feet | 250 to 500 feet | 500 to 1000 feet | Above 1000 feet

SCALE OF MILES 0 5 10 15 20

H.M. Stationery Office Press, Kingsway, W.C.2.

Pn.1677/635. Wt. 69. D.P.I. 1000. 12/22.